FINAL REPORT

EXECUTIVE SUMMARY

I-19 Corridor Profile Study

Nogales to Junction I-10

PREPARED FOR ADOT MARCH 2017

ADOT WORK TASK NO.
MPD 072A-14

ADOT CONTRACT NO.
11-013177

Prepared by

AECOM

EXECUTIVE SUMMARY

INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of Interstate 19 (I-19) between the International Border and Interstate 10 (I-10). This study examines key performance measures relative to the I-19 corridor, and the results of this performance evaluation will be used to identify potential strategic improvements. The intent of the corridor profile program, and of the Planning to Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network.

ADOT is conducting eleven CPS within three separate groupings. The I-19 corridor, depicted in **Figure ES-1**, is one of the strategic statewide corridors identified and the subject of this CPS.

Corridor Study Purpose, Goals and Objectives

The purpose of the Corridor Profile Study is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process described below:

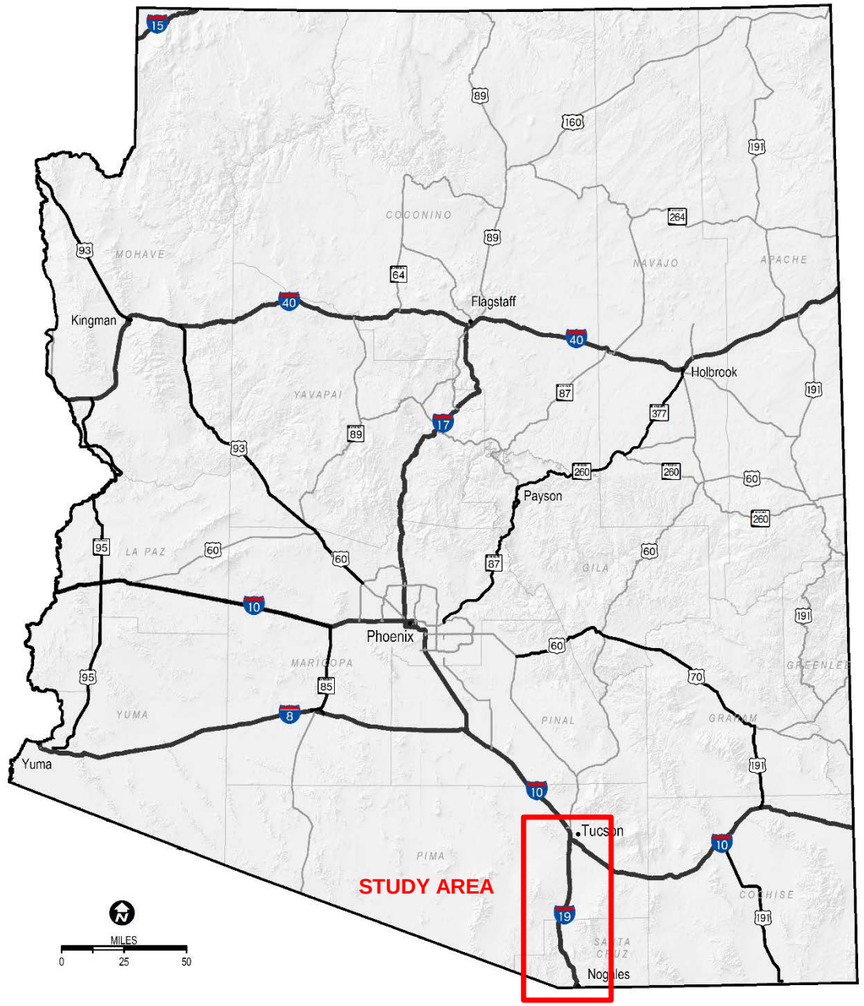
- Inventory past improvement recommendations
- Define corridor goals and objectives
- Assess existing performance based on quantifiable performance measures
- Propose various solutions to improve corridor performance
- Identify specific solutions that can provide quantifiable benefits relative to the performance measures
- Prioritize solutions for future implementation, accounting for performance effectiveness and risk analysis findings

The objective of this study is to identify a recommended set of prioritized potential solutions for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The I-19 Corridor Profile Study will define solutions and improvements for the corridor that can be evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance.

The following goals have been identified as the outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals.
- Develop solutions that address identified corridor needs based on measured performance.
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure.

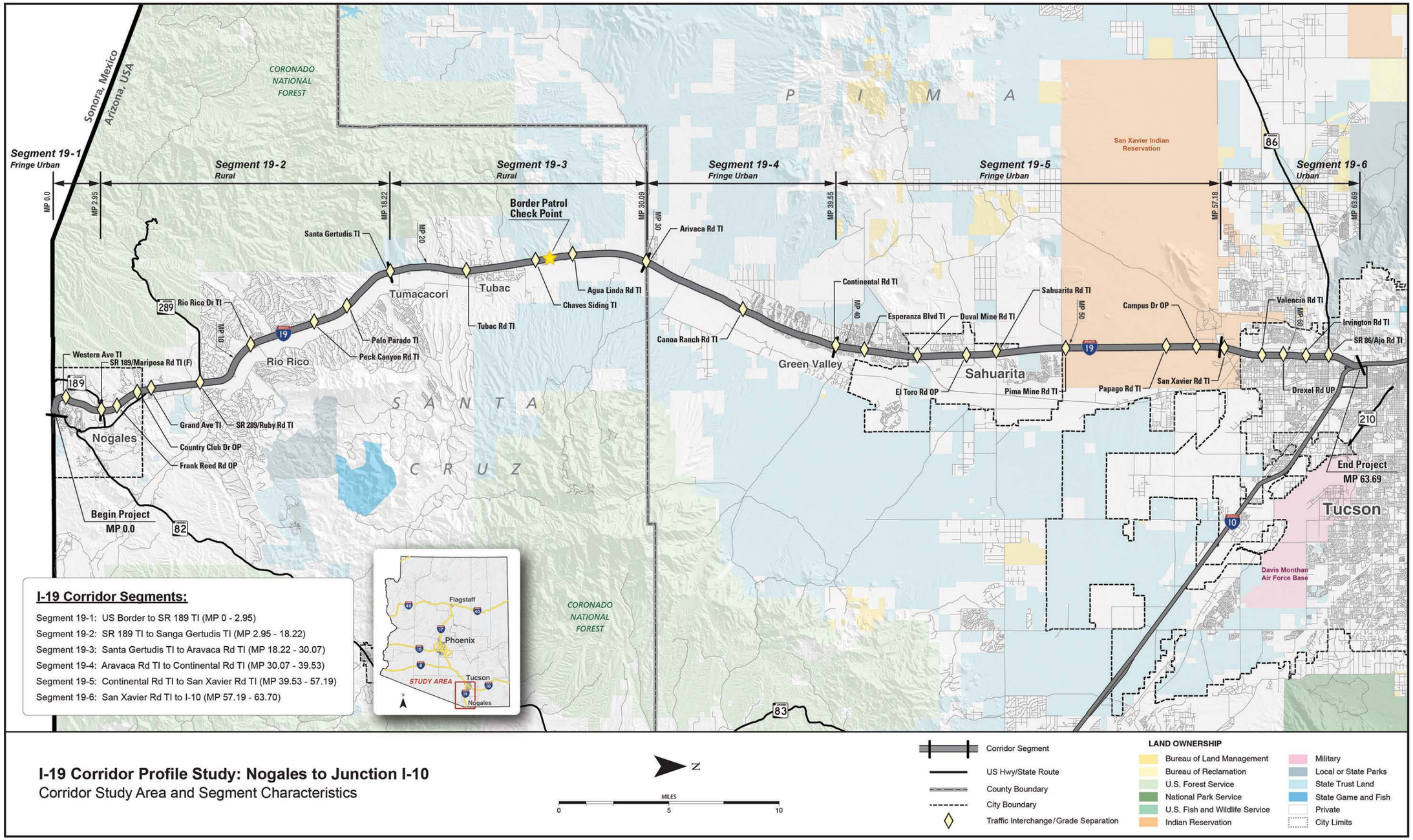
Figure ES-1: Corridor Study Area



Study Location and Corridor Segments

The I-19 Corridor is divided into 6 planning segments for analysis and evaluation. The corridor is segmented at logical breaks where the context changes such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are shown in **Figure ES-2**.

Figure ES-2: Corridor Location and Segments



CORRIDOR PERFORMANCE

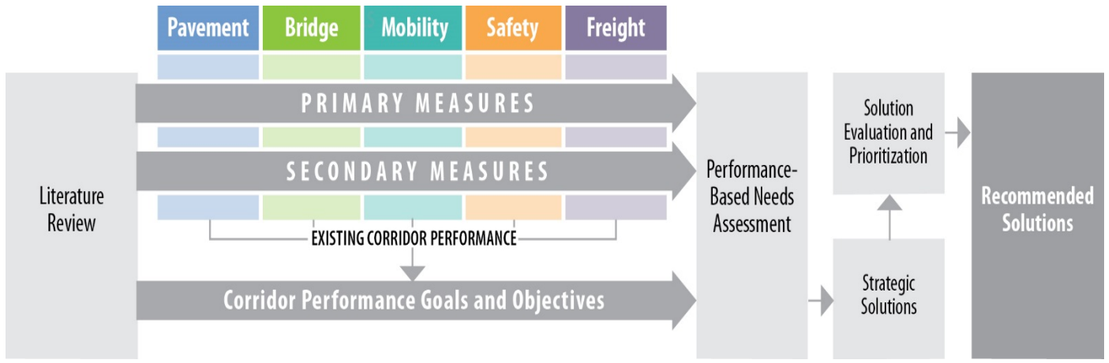
A series of performance measure were used to assess the I-19 corridor. The results of the performance evaluation were used to define overall corridor need relative to the long term goals and objectives for the corridor.

Corridor Performance Framework

This study uses a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the consultant teams for the Corridor Profile Studies.

Figure ES-3 illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance.

Figure ES-3: Corridor Profile Performance Framework



The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures were identified for a more detailed analysis of corridor performance. **Table ES-1** provides the complete list of primary and secondary performance measures for each of the five performance areas.

Table ES-1: Corridor Performance Measures

Performance Area	Primary Measure	Secondary Measures
Pavement	**Pavement Index** Based on a combination of International Roughness Index and Cracking	• Directional Pavement Serviceability • Pavement Failure • Pavement Hot Spots
Bridge	**Bridge Index** Based on lowest of deck, substructure, superstructure and structural evaluation rating	• Bridge Sufficiency • Functionally Obsolete Bridges • Bridge Rating • Bridge Hot Spots
Mobility	**Mobility Index** Based on combination of existing and future daily volume-to-capacity ratios	• Future Congestion • Peak Congestion • Travel Time Reliability • Multimodal Opportunities
Safety	**Safety Index** Based on frequency of fatal and incapacitating injury crashes	• Directional Safety Index • Strategic Highway Safety Plan Emphasis Areas • Crash Unit Types • Safety Hot Spots
Freight	**Freight Index** Based on bi-directional truck planning time index	• Recurring Delay • Non-Recurring Delay • Closure Duration • Bridge Vertical Clearance • Bridge Vertical Clearance Hot Spots

Each of the primary and secondary performance measures identified above is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

Good/Above Average Performance – Rating is above identified desirable/average range

Fair/Average Performance – Rating is within identified desirable/average range

Poor/Below Average Performance – Rating is below identified desirable/average range

The terms “good”, “fair”, and “poor” apply to the Pavement, Bridge, Mobility, and Freight performance measures, which have defined thresholds. The terms “above average”, “average”, and “below average” apply to the Safety performance measures, which have thresholds referenced to statewide averages.

Corridor Performance Summary

Table ES-2 shows a summary of corridor performance for all primary measures and secondary measure indicators for the I-19 Corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure as shown in **Table ES-2**.

- The most significant results for the I-19 corridor report Poor Safety performance on all segments except segment 19-4, including NB and SB lanes.
- Pavement performance is generally Good/Above Average throughout the corridor.
- Bridge performance is generally Good/Above Average throughout the corridor. Exceptions include a series of Functionally Obsolete bridges in segment 19-1 and an average bridge rating of 4 (Below Average) on segment 19-5.
- Mobility performance is generally Good/Above Average throughout the corridor. Exceptions include segment 19-6 in the Tucson urban area, where project traffic increases push the Mobility Index into the poor range.
- Freight performance is generally Good/Above Average throughout the corridor. Exceptions include a low clearance bridge on segment 19-5 and a corridor average PTI (NB) that is largely the result of:
    - Conditions on segment 19-1 which delay trucks from reaching signed speed limits, and
    - The US Customs Border Patrol Checkpoint on segment 19-3, where delays contribute to lower average speeds for the segment.

Table ES-2 shows a summary of all primary and secondary performance measures for the I-19 corridor. A weighted average rating (based on the length of the segment) was calculated for each primary and secondary measure as shown in **Table ES-2**.

Table ES-2: Corridor Performance Summary by Segment and Performance Measure

Segment	Length (miles)	Pavement Performance Area				Bridge Performance Area				Mobility Performance Area											
		Pavement Index	Directional PSR		Pavement Failure	Bridge Index	Bridge Sufficiency	Bridge Rating	% Deck Area of Functionally Obsolete Bridges	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/milepost / year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Acc.	% Non-Single Occupancy Vehicle (SOV) Opportunities
			NB	SB								NB	SB	NB	SB	NB	SB	NB	SB		
19-1[1a*]	3	4.03	3.72	3.96	16.7%	5.98	90.03	5	100.0%	0.16	0.19	0.12	0.11	0.27	0.20	1.40	1.01	2.28	1.30	90%	14%
19-2[2a^]	15	4.39	4.28	4.26	3.3%	5.79	92.24	5	27.3%	0.32	0.39	0.19	0.20	0.22	0.17	1.16	1.13	1.25	1.22	100%	17%
19-3[2b*]	12	3.57	3.74	3.90	0.0%	6.18	93.08	6	19.7%	0.26	0.32	0.17	0.17	0.30	0.17	1.58	1.10	2.50	1.17	100%	15%
19-4[1a^]	10	3.54	3.76	3.90	0.0%	6.60	95.35	6	15.7%	0.34	0.41	0.23	0.23	0.20	0.02	1.06	1.06	1.08	1.12	100%	16%
19-5[1a^]	17	4.08	3.97	4.02	0.0%	5.30	90.92	4	21.3%	0.56	0.66	0.35	0.36	0.25	0.15	1.06	1.07	1.11	1.12	100%	13%
19-6[1a^]	7	3.61	3.54	3.57	18.8%	6.06	77.36	5	19.4%	1.01	1.21	0.78	0.76	0.38	0.06	1.00	1.04	1.03	1.12	95%	15%
Weighted Corridor Average		3.92	3.91	3.98	3.6%	5.90	90.80	5.08	25.0%	0.44	0.53	0.30	0.30	0.26	0.13	1.19	1.08	1.44	1.16	99%	15%
Scale		Interstate								Urban or Rural						Uninterrupted or Interrupted					
Good/Above Average		> 3.75			< 5%	> 6.5	> 80	> 6	< 12%	< 0.71[1] < 0.56[2]				< 0.22		< 1.15^ < 1.30*		< 1.30^ < 3.00*		> 90%	> 17%
Fair/Average		3.2 - 3.75			5% - 20%	5.0 - 6.5	50 - 80	5 – 6	12% - 40%	0.71 - 0.89[1] 0.56 - 0.76[2]				0.22 – 0.62		1.15-1.33^ 1.30-2.00*		1.30-1.50^ 3.00-6.00*		60% - 90%	11% - 17%
Poor/Below Average		< 3.2			> 20%	< 5.0	< 50	< 5	> 40 %	> 0.89[1] >0.76[2]				> 0.62		> 1.33^ > 2.00*		> 1.50^ > 6.00*		< 60%	< 11%

Segment	Length (miles)	Safety Performance Area				Freight Performance Area							
		Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	Freight Index	Directional Truck TTI		Directional Truck PTI		Closure Duration (minutes/milepost closed/year/mile)		Vertical Bridge Clearance
			NB	SB				NB	SB	NB	SB	NB	SB	
19-1[1a*]	3	1.94	1.99	1.90	*Insufficient Data*	*Insufficient Data*	0.46	1.54	1.08	2.37	1.96	30.03	46.78	No UP
19-2[2a^]	15	1.33	1.34	1.32	59%	*Insufficient Data*	0.93	1.04	1.04	1.09	1.08	45.09	33.78	16.15
19-3[2b*]	12	1.36	1.59	1.12	33%	*Insufficient Data*	0.34	1.43	1.03	4.91	1.06	87.90	53.94	16.13
19-4[1a^]	10	0.52	0.59	0.44	44%	*Insufficient Data*	0.95	1.02	1.03	1.05	1.06	22.82	7.36	No UP
19-5[1a^]	17	1.48	2.11	0.86	39%	*Insufficient Data*	0.94	1.03	1.03	1.05	1.06	39.82	23.75	16.78
19-6[1a^]	7	1.42	0.80	2.04	53%	*Insufficient Data*	0.88	1.02	1.08	1.06	1.20	66.47	22.61	15.98
Weighted Corridor Average		1.29	1.45	1.13	45%	*Insufficient Data*	0.80	1.13	1.04	1.85	1.12	49.87	30.16	16.33
Scale		Urban 4 Lane Freeway or Rural 4 Lane < 25,000 vpd					Uninterrupted or Interrupted							
Good/ Above Average		< 0.79[a] < 0.73[b]			< 49.1%[a] < 42.8% [b]	N/A	> 0.77^ > 0.33*	< 1.15 ^ < 1.30*		< 1.30^ < 3.00*		< 44.18		> 16.5
Fair/ Average		0.79-1.21[a] 0.73-1.27[b]			49.1%-59.4%[a] 42.8%-52.9%[b]	N/A	0.67 - 0.77^ 0.17 - 0.33*	1.15 -1.33^ 1.30 -2.00*		1.30-1.50^ 3.00-6.00*		44.18 -124.86		16.0-16.5
Poor/ Below Average		> 1.21[a] > 1.27[b]			> 59.4%[a] > 52.9%[b]	N/A	< 0.67^ < 0.17*	> 1.33^ > 2.00*		>1.50^ > 6.00*		> 124.86		< 16.0

^Uninterrupted Flow Facility [a]Urban 4 Lane Freeway [1]Urban Operating Environment
*Interrupted Flow Facility [b]Rural 4 Lane < 25,000 [2]Rural Operating Environment

Note: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings

NEEDS ASSESSMENT

Corridor Description

The I-19 Corridor functions as a significant international and regional route, connecting the border city of Nogales to Tucson in southern Arizona. The corridor serves as a major truck route due to the border crossing, bringing manufactured goods and produce north from Mexico. ADOT has designated it as a critical link in Arizona's Primary Freight Network and the CANAMEX Trade Corridor. The connection to I-10 gives those products access to distribution points throughout the country.

Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP), 2010-2035. Statewide performance goals that are relevant to the I-19 performance framework areas were identified and corridor goals were then formulated for each of the five performance framework areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance three "Emphasis Areas" were identified for the I-19 corridor: Mobility, Safety, and Freight.

Taking into account the corridor goals and identified Emphasis Areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance Emphasis Areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas.

Achieving corridor and segment objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor. Corridor performance will be measured against corridor and segment objectives to determine needs – the gap between observed performance and the target.

Needs Assessment Process

The performance-based needs assessment evaluates the difference between the baseline performance and the performance objectives for each of the five performance areas used to characterize the health of the corridor: Pavement, Bridge, Mobility, Safety, and Freight. The performance-based needs assessment process is illustrated in **Figure ES-4**.

The needs assessment compares baseline corridor performance with the performance objectives to provide a starting point for the identification of performance needs. This mathematical comparison results in an initial need rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process is shown in **Figure ES-5.**

Figure ES-4: Needs Assessment Process

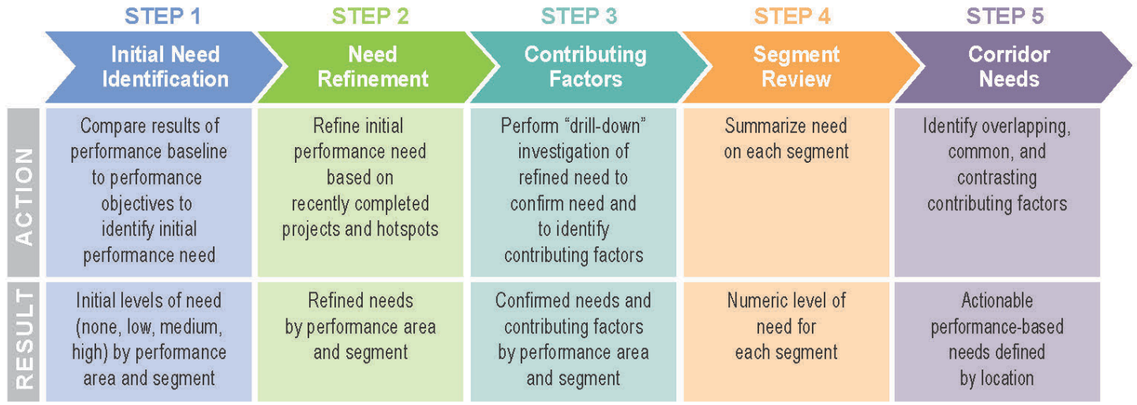


Figure ES-5: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)

Performance Thresholds	Performance Level	Initial Level of Need	Description
6.5	Good	None	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
	Good		
	Fair		
5.0	Fair	Low	Middle 1/3 of Fair (5.5-6.0)
	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5)
	Poor		
	Poor	High	Lower 2/3 of Poor (<4.5)
	Poor		

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final need rating for each segment. A detailed review of available data helps identify contributing factors to the need and if there is a high level of historical investment.

Summary of Needs

Table ES-3 provides a summary of needs for each segment across all performance areas, and the average needs for each segment. A weighting factor of 1.5 is applied to the average need scores of the performance areas identified as emphasis areas (mobility, safety, and freight for the I-19 corridor). There are no segments with a High average need, five segments with a Medium average need, and only one segment with a Low average need. More information on the identified final needs in each performance area is provided below.

Pavement Needs

- Overall final pavement needs are Low or None throughout the corridor. No changes to the level of need resulting from hot spot analysis occur on the corridor.
- The pavement hot spot on segment 19-2 at MP 17-18 was addressed in a 2015 improvement project.
- Other pavement hot spots were identified on approximately six miles of the corridor on three segments, but are generally expected to be mitigated through upcoming programmed projects.

Bridge Needs

- Bridge needs occur due to poor performing bridges or hot spots on four of six segments, with High needs identified in segment 19-5 and Medium needs identified in segment 19-1.
- Bridge needs were identified at 17 of the total 74 bridges (23%).
- Four bridges have potential historical issues and are candidates for life-cycle cost analysis to evaluate alternative solutions.
- Bridge hot spots along I-19 are not sufficient to change the Initial Need from its original calculated value.

Mobility Needs

- The Mobility Performance Area is an Emphasis Area for the I-19 corridor, giving it a heavier weight in the analysis.
- High Mobility Needs were identified only on segment 19-6 in the Tucson area related to high traffic volumes and poor level of service values.
- While commuting traffic from residential areas south of Tucson is partly responsible for heavier traffic volumes, traffic volumes are high seven days per week. This results from Tucson's position as the regional center for shopping, entertainment, and other services in addition to being an employment center.
- Directional TTI and PTI issues on segment 19-1 are attributed to slowdowns in truck traffic at grade level intersections in Nogales. Truck traffic is expected to be dramatically reduced with improvements to SR 189 connecting to the Mariposa International Border Crossing, reducing the level of need on the segment.

Safety Needs

- The Safety Performance Area is an Emphasis Area for the I-19 corridor, giving it a heavier weight in the analysis.
- High Safety Needs were identified in all segments except 19-4, resulting in Poor performance for the corridor as a whole.
- Multiple crash hot spots are identified, especially in the northern part of the corridor, segments 19-4 through 19-6.
- The high rate of serious injury and fatal crashes throughout the corridor may be attributed to outdated designs on some entrance ramps, lack of lighting, equipment failure, alcohol related crashes, low levels of seat belt use, and other driver behaviors.
- While a high rate of serious injury and fatal crashes is reported on segment 19-1, the low number of such crashes (2), especially within the Strategic Highway Safety Plan (SHSP) Top 5, reported during the analysis period points to caution in this result.
- Crashes involving trucks, motorcycles, and non-motorized during the analysis period were too few to provide significant results at any point on the corridor. Other crash types predominate.

Freight Needs

- The Freight Performance Area is an Emphasis Area for the I-19 corridor, giving it a heavier weight in the analysis.
- Final Freight Needs are Low or None throughout the corridor. In general, limits on truck travel and planning times are not significant factors.
- The most significant need shows a Low performance in the Bridge Clearance secondary measure. However, all of the low clearance bridges can be avoided by using ramps at the grade separated traffic interchanges and do not represent a hot spot under the criteria used for the analysis.
- Truck traffic is also affected by slowdowns in segment 19-3 related to the Border Patrol checkpoint north of Tubac, but is not sufficient to raise the level of need.

Overlapping Needs

This section identifies overlapping performance needs on the I-19 Corridor, which provides guidance to develop strategic solutions that address more than one performance are with elevated levels of need. Completing projects that address multiple needs presents the opportunity to more effectively improve overall performance. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- 19-1 – Bridge (Medium) and Safety (High) Needs are elevated in this segment within Nogales. This relatively short section (three miles) has lower traffic volumes than the rest of the corridor and transitions to interrupted flow characteristics. Improvements on SR 189 from the Mariposa Interchange south to the Mariposa Border Crossing will remove some pressure from the segment. The Bridge Needs relating to several functionally obsolete bridges and

Safety Needs related to high fatality rates were further evaluated in subsequent phases of the project.

- 19-5 - Bridge (High) and Safety (High) Needs are elevated in this segment in the Sahuarita area. Low performing bridges, including the El Toro Road Overpass, the Pima Mine Traffic Interchange, and the Santa Cruz River Bridge are noted. Crash hot spots and higher rates of serious injury crashes contribute to the elevated Safety Need.
- 19-6 - Mobility (High) and Safety (High) Needs are elevated in this segment within Tucson. Mobility issues are related to near-term growth in traffic volumes, putting the segment over capacity within 10 years. Safety Needs result from crashes associated with congestion and inadequate traffic interchange ramps.

Table ES-3: Summary of Needs by Segment

Performance Area	Segment	19-1	19-2	19-3	19-4	19-5	19-6
	Milepost	MP 0 - 3	MP 3 -18	MP 18 - 30	MP 30 - 40	MP 40 - 57	MP 57 - 64
Pavement		Low	Low	None*	Low	None*	Low
Bridge		Medium	Low	None*	None*	High	Low
Mobility		None*	None*	Low	None*	None*	High
Safety		High	High	High	Low	High	High
Freight		Low	Low	Low	None*	None*	Low
Average Need (0-3)		**1.38**	**1.23**	**1.15**	**0.38**	**1.15**	**1.92**

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Scale	
None	< 0.10
Low	0.10 - 1.00
Medium	1.00 - 2.00
High	> 2.00

STRATEGIC SOLUTIONS

The principal objective of the corridor profile study is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions was to identify areas of elevated levels of need as addressing these needs will have the greatest effect on corridor performance. Segments with Medium or High needs and specific locations of hot spots are considered strategic investment areas for which strategic solutions should be developed. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes.

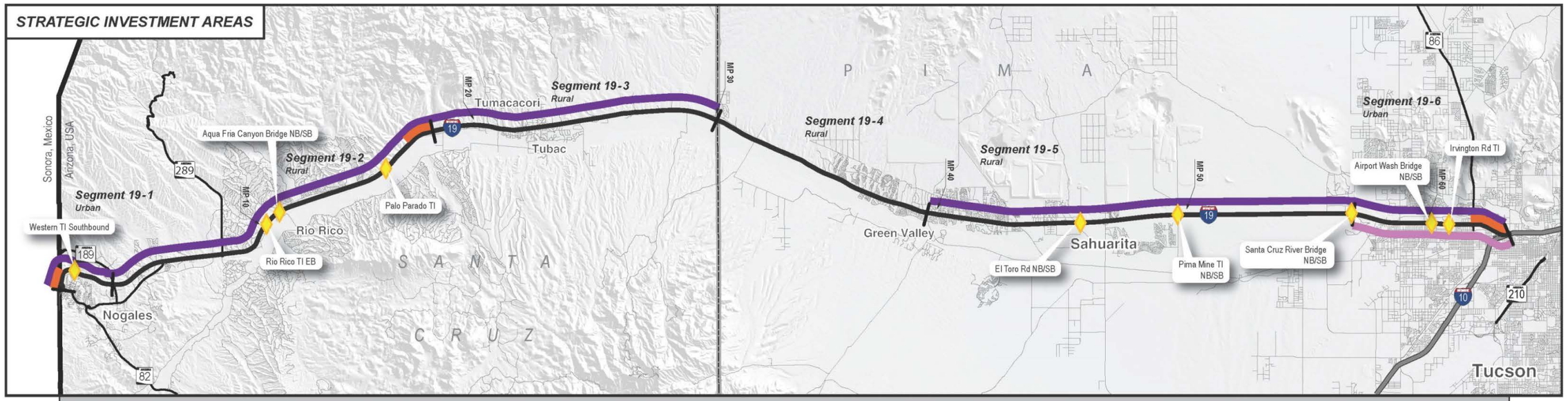
The I-19 strategic investments areas (resulting from the elevated needs) are shown in **Figure ES-6**.

Screening Process

In some cases, needs that are identified do not advance to solutions development and are screened out from further consideration because they have been or will be addressed through other measures including:

- A project has is programmed to address this need.
- The need is a result of a Pavement or Bridge hot spot that does not show historical investment issues. These hot spots will likely be addressed through other ADOT programming means.
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need. This bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes.
- The need is determined to be non-actionable (i.e., cannot be addressed through an ADOT project).
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need.

Figure ES-6: Strategic Investment Areas



	SEGMENT						
Segments	19-1	19-2	19-3	19-4	19-5	19-6	Segments
Pavement	Hotspot	Hotspot	–	–	–	Hotspot	Pavement
Bridge	Med	Hotspot	–	–	High	Hotspot	Bridge
Mobility	–	–	–	–	–	High	Mobility
Safety	High	High	High	–	High	High	Safety
Freight	–	–	–	–	–	–	Freight

I-19 Corridor Profile Study: Nogales to Junction I-10
Strategic Investment Areas

N

MILES
0 5 10

Corridor Segment
US Hwy/State Route
County Boundary
City Boundary

MAP SYMBOLOGY
SAFETY NEEDS
PAVEMENT NEEDS
FREIGHT NEEDS
MOBILITY NEEDS

LEVEL OF NEED
Low
Medium
High

Candidate Solutions

For each elevated need within a strategic investment area that is not screened out, a candidate solution is developed to address the identified need. Each candidate solution is assigned to one of the following three P2P investment categories based on the scope of the solution:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing candidate solutions for corridor preservation, modernization, and expansion. Candidate solutions are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the I-19 Corridor will be considered along with other candidate projects in the ADOT statewide programming process.

Candidate solutions include some or all of the following characteristics:

- Do not recreate or replace results from normal programming processes.
- May include programs or initiatives, areas for further study, and infrastructure projects.
- Address elevated levels of need (High or Medium) and hot spots.
- Focus on investments in Modernization projects (to optimize current infrastructure).
- Address overlapping needs.
- Reduce costly repetitive maintenance.
- Extend operational life of system and delay expansion.
- Leverage programmed projects that can be expanded to address other strategic elements.
- Provide measureable benefit (benefit/cost ratio, risk, LCCA, performance system, etc.).

Candidate solutions developed to address an elevated need in the Pavement or Bridge performance areas include two options; rehabilitation or full replacement. These solutions are initially evaluated through a Life-Cycle Cost Analysis (LCCA) to provide insights into the cost-effectiveness of these options so a recommended approach can be identified. Candidate solutions developed to address an elevated need in the Mobility, Safety, or Freight performance areas are advanced directly to the Performance Effectiveness Evaluation. In some cases, there may be multiple solutions identified to address the same area of need.

Candidate solutions that are recommended to expand or modify the scope of an already programmed project are noted and are not advanced to solution evaluation and prioritization. These solutions are directly recommended for programming.

SOLUTION EVALUATION AND PRIORITIZATION

Candidate Solutions were evaluated in multiple ways including a LCCA or BCA (where applicable), Risk Analysis, and a Performance Effectiveness Analysis. The methodology and approach to this evaluation is shown in **Figure ES-7** and described more fully below.

Life-Cycle Cost Analysis

All pavement and bridge candidate solutions have multiple options, rehabilitate the area of need, or fully reconstruct the issue area or structure. These options are evaluated through a LCCA to determine the best approach for each location where a pavement or bridge solution is recommended. The LCCA could eliminate options from further consideration and will identify which options should be carried forward for further evaluation.

All Mobility, Safety, and Freight strategic investment areas that result in multiple independent candidate solutions are advanced directly to the Performance Effectiveness Evaluation.

LCCA was performed on four bridge solutions for the I-19 corridor. Of the four bridges subjected to LCCA, rehabilitation was determined to be the most effective solution in each location.

Performance Effectiveness Evaluation

After the LCCA process are complete, all remaining candidate solutions are evaluated based on their performance effectiveness. This process includes determining a performance effectiveness score (PES) based on how much each solution impacts the existing performance and needs scores for each segment. This evaluation also includes a Performance Area Risk Evaluation to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

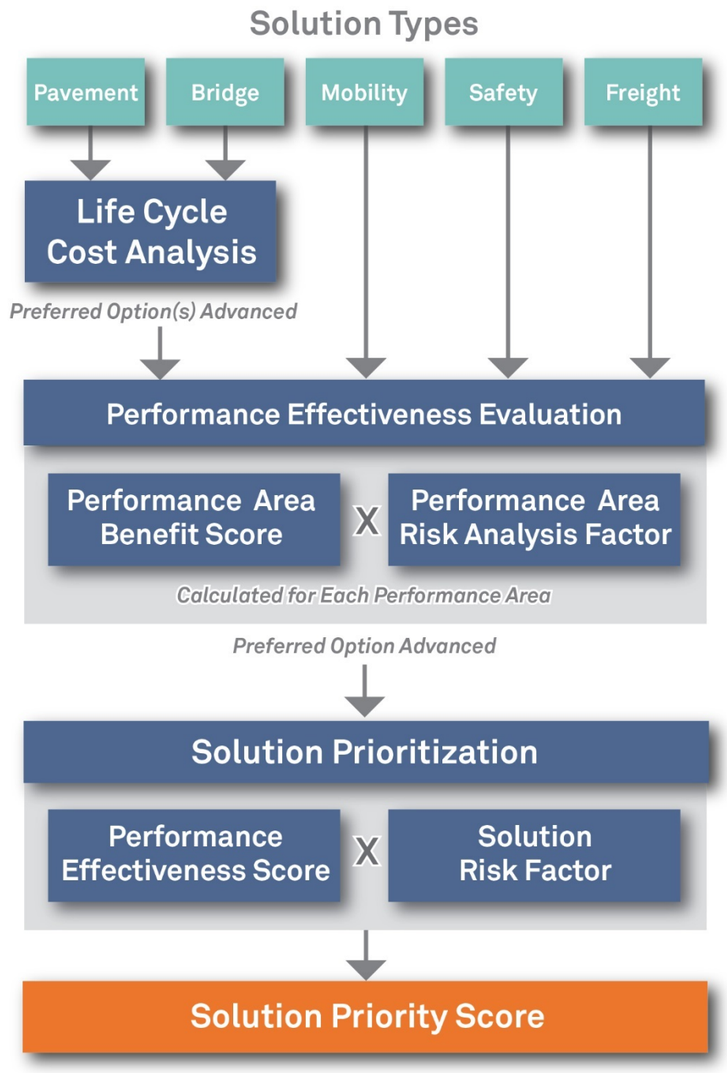
Risk Analysis

All candidate solutions advanced through the Performance Effectiveness Evaluation are also evaluated through a Risk Analysis process. The risk analysis is conducted to develop a risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of the performance failure.

Candidate Solution Prioritization

The PES and risk factor are combined to create a prioritization score. The candidate solutions are ranked by prioritization score from highest to lowest. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Solutions that address multiple performance areas tend to score higher in this process.

Figure ES-7: Candidate Solution Evaluation Process



SUMMARY OF CORRIDOR RECOMMENDATIONS

Prioritized Candidate Solution Recommendations

Table ES-4 and **Figure ES-8** show the prioritized candidate solutions recommended for the I-19 Corridor. The recommended solutions are shown in. These solutions will increase the performance of the I-19 corridor across a majority of the performance areas. Solutions that address multiple performance areas tend to score higher in this process. The highest ranking projects tended to have overlapping benefits in Safety, Mobility, and Freight.

- Two of the top three projects include shoulder and roadside improvements through much of the corridor that will reduce the incidence of run off the road type vehicle crashes that often result in fatal and serious injuries.
- Additional benefits to Mobility and Freight will occur due to the reduction in the number of incidents that cause delays along I-19.
- The I-19 Tucson Widening project will increase capacity on this congested segment, reduce delays, and improve safety.
- The Ajo Way/I-19 Pavement Rehabilitation project scored well due to extending the improvements of a previously programmed project to address pavement issues.
- The Drexel/Irvington Pedestrian Overpass and Barrier Fencing project will help reduce the high number of fatal vehicle-pedestrian crashes resulting from pedestrians attempting to cross I-19.
- The remaining traffic interchange ramp and lighting improvements will increase safety at those locations as well as improve traffic throughput by reducing delay and the potential for conflicting movements in the merge areas.

Other Corridor Recommendations

As part of the investigation of strategic investment areas and candidate solutions, other corridor recommendations were also identified. These recommendations could include modifications to the existing Statewide Construction Program, areas for further study, or other corridor specific recommendations that are not construction or policy related. The list below identified other corridor recommendations for the I-19 corridor:

- The analysis shows a high ratio of fatal to incapacitating injury crashes that are not clearly patterned to specific locations. This report recommends that a Roadway Safety Analysis should be conducted on the corridor in order to better understand the high occurrence of fatal crashes.
- Consider a corridor strategy to upgrade all bridges to current standards in anticipation of increased truck/freight traffic over the medium to long term.
- Consider corridor wide ITS solutions to assist truck/freight traffic over the medium to long term.
- Advance Irvington Rd TI Underpass to construction programming. Irvington Rd TI has design funds only programmed in the Pima Association of Governments (PAG) five year transportation facilities construction program for fiscal year 2019.
- Extend the limits of the Ajo Way TI Phase 2 scope to reach the pavement hot spot at milepost 63 in fiscal year 2018.
- When recommending future projects along I-19, review historical ratings and levels of investment. According to data used for this study, the following pavement and bridge locations have exhibited high historical investment (pavement) or rating fluctuation (bridge) issues:
  - Pavement MP 6-9
  - Western Ave TI OP NB (MP 1.17)
  - Pajarito Rd OP NB/SB (MP 3.67)
  - Ruby Road TI UP (MP 7.7)
  - Agua Fria Canyon Bridge NB/SB (MP 11.97)
  - Peck Canyon TI UP (MP 13.96)
  - Peck Canyon Wash SB (MP 14.37)
  - Palo Parado Rd (MP 15.65)
  - Agua Linda UP (MP 26.54)
  - El Toro Rd OP NB/SB (MP 45.80)
  - Pima Mine TI OP NB/SB (MP 49.62)
  - Papago Rest Area TI OP NB/SB (MP 54.40)
  - Santa Cruz River Bridge NB/SB (MP 56.80)
  - Airport Wash Bridge NB/SB (MP 60.32)

Policy and Initiatives Recommendations

In addition to location-specific needs, general corridor and system-wide needs have also been identified through the CPS process. While these needs are more overarching and cannot be individually evaluated through the CPS process, it is important to document them. A list of recommended policies and initiatives was developed for consideration when programming future projects not only on I-19, but across the entire state highway system where conditions are applicable. The following list, which is in no particular order of priority, was derived from the Round 1, Round 2, and Round 3 CPS:

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic messaging signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects; in pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16.25 feet where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent; additional coordination for data on tribal lands is recommended to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends that may result from improvements and expansions to the state roadway network

Next Steps

The candidate solutions recommended in this study are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the I-19 Corridor will be considered along with other candidate projects in the ADOT statewide programming process.

It is important to note that the candidate solutions are intended to represent strategic solutions to address existing performance needs related to the Pavement, Bridge, Mobility, Safety, and Freight performance areas. Therefore, the strategic solutions are not intended to preclude recommendations related to the ultimate vision for the corridor that may have been defined in the context of prior planning studies and/or design concept reports. Recommendations from such studies are still relevant to addressing the ultimate corridor objectives.

Upon completion of all three CPS rounds, the results will be incorporated into a summary document comparing all corridors that is expected to provide a performance-based review of statewide needs and candidate solutions.

Table ES-4: Prioritized Recommended Solutions

Rank	Candidate Solution #	Solution Name and Location	Description/Scope	Estimated Cost ($ million)	**Investment Category (Preservation [P], Modernization [M], Expansion [E])**	Prioritization Score
1	CS19.15	Drexel/Irvington Pedestrian Overpass (I-19 MP 59.5-62)	Construct pedestrian overpass between Drexel and Irvington; construct 8' barrier fencing Valencia to Ajo Way (east side) and between Drexel and Irvington Rd (west side)	$2.25	M	**188**
2	CS19.14	Tucson Area GP Widening (I-19 MP 57-61.9)	Construct new general purpose lane (inside) in NB/SB direction between Irvington Rd and San Xavier Rd	$33.43	E	**106**
3	CS19.6	Sahuarita to Tucson Shoulder & Roadside Improvements (I-19 MP 39.5-61.9)	Rehabilitate shoulders in both directions from Sahuarita Rd to Irvington Rd.	$13.79	M	**89**
4	CS19.1	Nogales to Tubac Shoulder & Roadside Improvements (I-19 MP 3-30)	Rehabilitate shoulders in both directions from the SR189 TI to Aravaca Rd TI	$15.19	M	**74**
5	CS19.12	Tucson Area Parallel Ramps (I-19 MP 57-61.9)	Modify entry/exit ramps to parallel configuration Implement ramp metering at Irvington Rd SB, Valencia Rd NB/SB, and San Xavier Rd NB	$13.94	M	**47**
6	CS19.13	Tucson Variable Speed Limits (I-19 MP 57-64)	Implement Variable Speed Limits (both directions)	$24.99	M	**31**
7	CS19.5	Sahuarita to Tucson Lighting (I-19 MP 39.5-60)	Install lighting (both directions)	$27.52	M	**16**
8	CS19.3	Nogales to Tubac Lighting (I-19 MP 3-30)	Install lighting (both directions)	$36.25	M	**16**
9	CS19.10	Pima Mine TI Ramp Improvements (I-19 MP 49.6)	Modify entry/exit ramps to parallel configuration	$5.60	M	**13**
10	CS19.11	Papago TI Ramp Improvements (I-19 MP 54.4)	Modify entry/exit ramps to parallel configuration	$4.43	M	**6**
11	CS19.9	Sahuarita TI Ramp Improvements (I-19 MP 46.8)	Modify entry/exit ramps to parallel configuration	$4.43	M	**1**

Figure ES-8: Prioritized Recommended Solutions